A little study of weather types on the Pacific Slope makes it plain that certain conditions traverse the country from the Pacific; thus to take at random the month of January, 1895, some of the deep lows that might have been supposed to originate over Manitoba or further west over Assiniboia, Alberta, and British Columbia, did not so originate but are storms that can be traced distinctly in their onward march from the northern-central Pacific Ocean northeastward, often recurving and doubling in their paths, but preserving identity. Passing south of Sitka they march eastward and reach Newfoundland in about 120 hours. For example, a storm passed from Sitka to St. Johns between January 12 and 17. This storm did *not* originate in the Northwest Territory but clearly came in from the Pacific. Where it did originate we do not know, but it is an error to locate its origin in any of the Northwest Territories. And this is probably true of most storms which are said to originate over Athabasca or Saskatchewan. The truth is that storms first come into notice in these localities but originate elsewhere.

In preparing the chapter on high and low areas for the MONTHLY WEATHER REVIEW for January, 1895, Mr. A. J. Henry (whose name in the absence of the Editor was accidentally omitted in that connection) makes note on page 3 of the fact that:

The storms of the Pacific Coast present a characteristic that is worthy of special study, viz, an apparent oscillation from the ocean to the land, and *vice versa*, that is to say, the low approaches the coast and partially disappears, reappearing within a period of twelve to thirty-six hours, and continuing this action until the storm finally disappears.

This same phenomenon has recently been indepently noted by Mr. W. H. Hammon, Forecast Official, Weather Bureau at San Francisco, who, under date of November 14, states that:

During the past two years I have been engaged during my leisure time in preparing weather charts of the Pacific Ocean. Some remarkable information has been obtained from these charts. The storms that approach the Pacific Coast from the ocean, frequently recurve several times after touching the coast, the number of such oscillations being greater the farther south the storm approaches the coast.

The fact that a storm moves southward, ricochetting along the Pacific Coast, and probably dying away as it progresses, harmonizes with the general theory of the movement of vortices. If the general distribution of pressure at sea level, and especially at 16,000 feet, is such as to give the storm center a general movement southward or southeastward along the Pacific Coast, then the influences of the high mountain land in the interior of California and of the plateau lands of Idaho, Nevada, Oregon, Utah, and Arizona are like those of a barrier against which a small atmospheric vortex may strike only to be reflected several times in succession. A further special influence of these high lands is to furnish descending dry air whose mixture with the moist air of the whirlwind rapidly diminishes the quantity of condensation and the sustaining power of the whole mechanism. The inverse conditions prevail on the east slope of the Rocky Mountains, where, therefore, a whirl once started is apt to increase in all characteristic phenomena. Possibly this process is illustrated by the low area of October 29, 1886, in regard to which Mr. McAdie writes:

On Monday, October 26, a. m., a low, 26.70, with southeast winds, appeared on the Oregon coast. Taking a most unusual course this storm passed southward, and on the morning of the 27th was over central California (San Francisco, 29.56, southeast wind, 1.10 inches rainfall). By 10 o'clock of the same day the storm was moving up the San Joaquin Valley, and heavy rain was falling over southern California. On the morning of the 28th the pressure was 29.78 at El Paso, with rain, and the storm was out of our limits of observation, but just coming into prominence elsewhere. Its subsequent history is plain.

HIGH-LEVEL ISOBARS.

In a preceding note the Editor has remarked that the movements of low areas across North America are elucidated by studying the upper isobars of the Northern Hemisphere. Maps of these isobars would doubtless be more frequently constructed and studied were we not hindered by the apparent uncertainty of reducing pressures observed at a low level upward to some considerable altitude; especially might one be hindered by the great labor of computing many such reductions. A rigorously correct reduction upward requires that we know the average temperature of the column of air above each station, and this is practically impossible in the present state of meteorology, though it may become practicable when balloons and kites have been more widely utilized. Meanwhile we must be content with rather crude approximations, but this will not lead us astray if we keep clearly before us the extent to which our data are liable to be in error. The preparation of a daily chart of upper isobars, say for 8 a. m. and 8 p. m., standard time, could hardly be seriously undertaken unless we had actual observations of the upper temperatures from balloons or kites or mountain peaks, but the preparation of monthly and annual normal charts for the level of 5,000 meters may, perhaps, be undertaken with satisfactory success at the present time. The laborious numerical computations of the pressures at this upper level can be entirely avoided by using the very convenient method suggested by Moeller in 1882, and elaborated by Koeppen in the *Met. Zeitschrift* for December, 1888. By omitting illusory refinements Koeppen has thrown all the labor into the use of a single table, which he gives in metric measures. The following table reproduces in English measures the second of the tables given by Koeppen.

Atmospheric pressure at 5,000 *meters, or* 16,404 *feet.*

[The arguments are: Pressure at sea level, and the average temperature of the intervening layer of air, which is approximately the actual temperature at 2,500 meters.]

Column temperatures (Fahrenheit).	Sea-level pressure (inches).								
	27.99	28.37	28.74	29.13	29.52	29.92	30.32	30.73	31.14
°	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
75.2	15.82	16.04	16.25	16.47	16.69	16.92	17.15	17.37	17.61
63.7	15.61	15.82	16.04	16.25	16.47	16.69	16.92	17.15	17.37
52.7	15.41	15.61	15.82	16.04	16.25	16.47	16.69	16.92	17.15
42.1	15.20	15.41	15.61	15.82	16.04	16.25	16.47	16.69	16.92
32.0	15.00	15.20	15.41	15.61	15.82	16.04	16.25	16.47	16.69
21.9	14.80	15.00	15.20	15.41	15.61	15.82	16.04	16.25	16.47
12.2	14.61	14.80	15.00	15.20	15.41	15.61	15.82	16.04	16.25
3.0	14.41	14.61	14.80	15.00	15.20	15.41	15.61	15.82	16.04
− 6.0	14.22	14.41	14.61	14.80	15.00	15.20	15.41	15.61	15.82
−14.8	14.03	14.22	14.41	14.61	14.80	15.00	15.20	15.41	15.61
−23.3	13.85	14.03	14.22	14.41	14.61	14.80	15.00	15.20	15.41
−31.4	13.66	13.85	14.03	14.22	14.41	14.61	14.80	15.00	15.20
−39.1	13.48	13.66	13.85	14.03	14.22	14.41	14.61	14.80	15.00
−46.7	13.30	13.48	13.66	13.85	14.03	14.22	14.41	14.61	14.80
−53.9	13.13	13.30	13.48	13.66	13.85	14.03	14.22	14.41	14.61

This table is so arranged that the same pressure at the upper level, for instance 16.25 inches, is repeated as we proceed downward and to the right; that is to say, there is a series of pairs of sea-level pressures and column-temperatures that will reproduce the same upper level pressure, *e. g.*, 75.2° and 28.74 inches; 63.7° and 29.13 inches; 52.7° and 29.52 inches, etc. In other words, a lower column-temperature may so counterbalance a higher sea-level pressure as to give the same upper-level pressure. One method of using this table consists in picking out by interpolation the upper reduced pressure for any given column temperature and sea level pressure, but this would be very laborious on account of the double interpolation, even if our little table were enlarged tenfold. By far the most expeditious method of applying Koeppen's table was suggested by Moeller and is as follows: Let there be given a chart of sea-level isobars and isotherms; assume a rate of upward diminution of air temperature and calculate how much this would amount to in 2,500 meters; subtract this amount from the temperatures inscribed at the end of our sea-level isotherms, and they at once become isotherms for the level of 2,500 meters, that is to say, they represent the average temperature of a layer 5,000 meters thick, or the argument that appears in the left-hand column of the above table. We now draw another set of 2,500 meter isotherms, which are interpolated between those already drawn, so as to exactly represent the column-temperatures, 75.2° F., etc., as given in the above table. In a similar way we now draw a second set of sea-level isobars by interpolation between those already drawn on the map, which new isobars shall represent the pressures, 27.99 inches, 28.37 inches, etc., as given at the heads of the respective columns of the above table. Where the new isotherm of 75.2° intersects the isobar, 27.99 inches, we have a point that may be marked as belonging to the upper isobar of 15.82 inches. Another point on this same isobar will be the intersection of the isotherm 63.7° F. with 28.37 inches; another point will be the intersection of 52.7° with 28.74 inches, etc. By joining these points, therefore, we have at once the upper isobar of 15.82 inches. In this way the laborious computation is wholly avoided, and the entire process consists simply in drawing on the original chart two new sets of isobars and isotherms properly related to each other as required by the above table, so that by joining the intersections of these new curves we at once construct the upper isobars.

Usually the principal source of uncertainty in the upper isobars is due to the temperature assumed for the 2,500 meter level and it is very possible that there may be an error of 10° F. in this datum; the above table shows that such an error will affect the upper isobar by about 0.2 inch, but the error will probably be quite symmetrical over large regions and will, therefore, not seriously affect the general contour of these isobars or the gradients between them.

Bearing in mind this uncertainty of the temperature, the accompanying Chart VII was constructed in 1895, according to the above method, from the charts given by Buchan in his Report on Atmospheric Circulation which is Part V of the Physics and Chemistry of the second volume of the Scientific Results of the Voyage of H. M. S. *Challenger*. Buchan's maps represent the normal data for December for the Northern Hemisphere. His isobars represent pressures reduced to standard gravity. In order to avoid confusion the sea-level isobars and isotherms have been omitted from Chart VII and only the upper-level isobars for 5,000 meters are shown. These upper isobars evidently constitute a single system from the equator to the polar regions. The special oceanic low pressures, which are a marked feature in the North Atlantic and North Pacific in December, almost disappear, being represented only by a widening of the upper isobars for a short distance between Iceland and France and in Bering Sea. On the other hand the continental areas of high pressure are now converted into smooth isobars tending to low pressures.

These upper isobars represent the result rather than the cause of the general circulation of the atmosphere. If it were not for the irregular resistances and temperatures over the continents and oceans we should undoubtedly have symmetrical circular isobars representing a maelstrom with the north pole at the centre and due to the general flow of the upper air from the equatorial belt toward and around the polar regions. As it is, however, the warmer temperature, the moisture, and the absence of special resistances, over the North Pacific and the North Atlantic oceans, combine with the low temperature, the dryness and the large resistances over the Eastern and Western continents, to produce winds that determine an oval system of upper isobars whose longest axis reaches from Hudson Bay toward the northwest over the polar regions into eastern Siberia and the valley of the Lena. If the temperature of the column of air has been assumed too low in the northern regions, as is rather likely, then our upper isobars may be a little too low and upper gradients too steep, but with due allowance for this uncertainty it still remains true that the presence of the great continents has distorted the symmetrical circles into very long ovals. The general path of a particle of atmosphere at this upper level can be approximately estimated from these upper isobars; it must be steadily descending in its circulation around the Arctic regions and the principal places of descent must be over the continents, *i. e.*, in the valley of the Mackenzie and upper Missouri, as it tries to turn the sharp curve at the American end of the oval and, again, over northern Russia and Siberia, as it tries to turn the sharp curve in the upper isobars over China and Siberia.

The study of these upper isobars explains the fact that the high pressure areas of North America in the first part of their course are usually observed to move from the northwest while similar areas in Europe move at first from the southwest but afterwards from the west. The great area of high pressure and cold, clear weather that prevailed over southern Europe November 17–27, finally disappearing over Persia, is a good example of such motion eastward; as a result it is quite possible that this area may have brought to upper India light snow, followed by cold, dry weather, about the 1st of December, 1896.

The upper currents over the North Pacific drive a mass of air eastward or southeastward over Alaska and British America, where it settles down, and by reason of its greater coldness, density, and centrifugal force, is driven southward as cold waves over the United States. Similarly, the strong west current over the North Atlantic forces a mass of air over Sweden and Russia that must eventually spread southeastward either as a "buran" over Siberia and China, or as a cold wave over Persia into northern India. At the surface of the Eastern and Western continents there is a flow of cold, dry air southeastward (sometimes southwestward) that is the mechanical consequence of the locations of the two oceans in respect to these continents, by reason of which the west and southwest winds have free sweep over the oceans on the west. By this arrangement Ferrel's symmetrical circulation over an ideal smooth globe, which would always represent a condition of unstable equilibrium and numerous discontinuous motions, is converted into an almost stable system of circulation during December, January, and February; not indeed a perfectly stable, steady motion, but an approximation thereto which would doubtless become perfect if the winter season lasted continually.

THE TENNESSEE RIVER AND FLOOD SYSTEM.

Mr. L. M. Pindell, Weather Bureau observer, in charge of the Chattanooga station and Tennessee River and Flood Service, has just published a general report, with the permission of the Chief of the Bureau, and by means of funds contributed by the business men of Chattanooga. The object of the report is to give the public all the information collected, and to so classify the data that any one can use the same with success. Besides giving all detailed river data for ten stations, and a special report on the flood of April, 1896, there are some interesting general paragraphs relative to other floods, and the following, which we quote, relative to the general regimen of the Chattanooga watershed:

The waters from Virginia and North Carolina help to feed the volume of the Tennessee River at Chattanooga, and eventually pass into the Cumberland River at Paducah, Ky. The French Broad, Holston, and Clinch rivers are the most important factors in furnishing the Tennessee her water supply. The Little Tennessee is also an important river, but the rise in this tributary, while of considerable height and importance, does not affect the main body of the Tennessee River like the Clinch or French Broad. The Hiawassee is a very quick and rapid rising tributary. It sometimes rises 10 to 12 feet in one day, and falls from 6 to 9 feet the next. This river generally checks the falling tendency of the Tennessee. A heavy rainfall and a rapid rise over the Hiawassee will only cause a rise of about 3 feet at Chattanooga. The drainage area above Chattanooga is 21,000 square miles; 2,800 above Clinton; 16,200 above Kingston or Rockwood; 3,400 above Strawberry Plains; 8,300 above Knoxville; 11,500 above Loudon, and 2,200 above Charleston.

Under ordinary conditions, that is, when the ground is fairly moistened and does not absorb very much of the rainfall, and when the rainfall is general over the entire system, the rise at Clinton and Kingston averages 3.9 feet for every inch of rainfall; 3.6 feet at Knoxville, Lou-